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Effect of Dietary Maltose on growth and feed Utilization of Nile Tilapia (O. Niloticus) Fingerlings

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Abstract

An experiment was conducted to determine the effects of dietary maltose level on growth performance and feed utilization of Nile tilapia, Oreochromis niloticus fingerlings. Five treatments, including control with three replicates with setup. Randomized distributed of fingerlings (mean weight, 2.1 ±0.2 g) were stocked in 30 fishes per tank, which attached with recycled water system comprising of mechanical filtration and aerated using air stones. The temperature was 27.5±0.25°C throughout the experimental period. Pellet of formulated-diets containing 0.0, 20, 25, 30 or 35% maltose was handed fed to apparent satiation twice daily at a rate of 5% of live body weight. The fishes were weighed once every 2 weeks during the experiment for 12 weeks. No casualty of Nile tilapia was recorded throughout the experiment. Fishes fed with 35 % maltose exhibited significantly higher growth performance; body weight and weight gain compared with control. The best specific growth rate (SGR) was obtained of fishes fed with feed E (1.44±0.04), but no significant difference compared with control, while fishes fed with feed B exhibited the lowest SGR value (1.34±0.05). Feed conversion ratio (FCR) in fishes fed with 35% maltose (1.01±0.02) was greater than 20, 25 or 30% maltose (1.16 to 1.26). Although, fishes fed with 20% maltose exhibited the lowers FCR (1.26±0.03) compared to all groups, but it's not different significantly compared to 35% maltose treated fish and control (1.07±0.01). This finding indicated that incorporation of maltose in fish diet had been efficiently utilized for Nile tilapia and contributed to their body-mass.

Keywords: Oreochromis niloticus, maltose, growth performance and feed utilization.

Introduction

Carbohydrate is the most economical energy source in the diet of animals, including fish. The ability of fish to utilize carbohydrate differs significantly between species[1]. In tilapia species can use much more amounts of dietary carbohydrate than the marine fishes[2]. Carbohydrates are one of the main nutritional components not only for energy source but also have a protein sparing effect in fish[3].

The relation use of dietary carbohydrates level by fish differs and appears to be related with carbohydrates structure[4,5]. In addition, malt sugar or maltose is the least common disaccharide in nature. It is present in germinating barley seeds. In contrast, most of the studies focused on formulations to contain different carbohydrate sources in the diet rather than it utilization efficiency by fish.

Channel catfish uses polysaccharides for growth better than other saccharides[6]. In contrast, White sturgeon uses monosaccharide and disaccharide better than polysaccharides[7]. While, Akiyama *et al.*,[8] and Buhler., Halver,[9] they were found Chum salmon and Chinook salmon used glucose, maltose, sucrose, dextrin, and starch but not galactose, fructose, and lactose for growth. A similar result was observed when tilapia fed on diets contained sucrose, maltose, and lactose; the growth was highest when fed with the maltose, followed by the sucrose and lactose diets in decreasing order[10]. To date, few reports have been published regarding maltose utilization of tilapia[11,12] from various sources.

Therefore, the purpose of the current study was to evaluate the effect of malt-extracted maltose at different levels in the formulated-dieton growth and feed utilization of Nile tilapia (*Oreochromis niloticus*) fingerlings.

Material and Methods

Feeds preparation: Feeds were prepared in the laboratory of Fresh Water Hatchery, Faculty of Fisheries and Aqua-Industry, University Malaysia Terengganu, Malaysia. Simple formulation for feeds was carried out using to excel software program (on dry matter basis).

Five iso-nitrogenous and iso-caloric diets were formulated to contain different levels of maltose 0.0, 20, 25, 30, and 35%, which extracted from barley as the carbohydrate sources. Fish meal used as animal protein source, while, soya meal as plant protein source, palm oil as the lipid source, wheat flour, cellulose which extracted from the barley husk was replaced gradually by maltose, and carboxymethyl cellulose used as a binder.

The formulation and proximate analysis of experimental diets were presented in Table-1 and Table-2. Macro and micro ingredients were mixed and homogenized, separately. The water was added to the homogenous content in a bio-mixed until dough was formed. Pellet of 2.5 mm diameter were produced using meat mincer (ORIMAS, TBS200 model, China), and oven dried for 48 hours at 55 °C and subsequently broken manually to small sizes, packed in plastic bags and stored in room temperature.

Chemical analysis of diets: The tried diets from each treatment were analyzed according to the standard methods[13]. Dry matter was obtained after drying in an oven at 105°C for 24 hrs until constant weight. Nitrogen content was measured using Kjeldahl method using Kjeltec™, 2100 FOSS and crude protein was estimated by multiplying nitrogen content by 6.25. Total lipids were determined by petroleum ether extraction. Ash was determined by burning in a muffle furnace at 600°C for 6 hrs. Crude fibre was extracted by filter bag using an ANKOM Fiber Analyzer (Model No: ANKOM^{200}, Ankom Technology, Macedon, NY) described by Vansoest*et al.*[14]. Nitrogen free extracted was calculated by subtracting the total percentages of moisture, crude protein, crude lipid, ash and crude fibre from 100%. Total energy was calculated from published values for the diet ingredients[1]. Samples were analysed in triplicate.

Table-1
Composition of different ingredients in the formulated feeds

Ingredient	Feed A (0.0 % Malt)	Feed B (20 % Malt)	Feed C (25 % Malt)	Feed D (30 % Malt)	Feed E (35 % Malt)
Fish meal	12	12	12	12	12
Soya bean	38	38	38	38	38
Wheat flour	10	10	10	10	10
Maltose	0	20	25	30	35
Cellulose	35	15	10	5	0
Palm oil	3	3	3	3	3
Mineral premix	0.5	0.5	0.5	0.5	0.5
Vitamin premix	0.5	0.5	0.5	0.5	0.5
Vitamin C	0.4	0.4	0.4	0.4	0.4
Binder (CMC)	0.5	0.5	0.5	0.5	0.5
Chromic oxide	0.1	0.1	0.1	0.1	0.1

Table-2
Mean ±S.E. proximate analysis and gross energy of the test feeds ((% dry matter)

	Feed A (0.0 % Malt)	Feed B (20 % Malt)	Feed C (25 % Malt)	Feed D (30 % Malt)	Feed E (35 % Malt)
Moisture	8.86±0.93 a	8.39±0.82 a	9.22±0.49 a	9.82±0.63 a	9.62±0.03 a
Protein	33.27±0.87a	33.70±0.43 a	33.85±0.29 a	33.56±0.73 a	33.27±0.44 a
Lipid	4.67±0.04 a	4.83±0.04 a	4.68±0.08 a	4.83±0.17 a	4.67±0.01 a
Ash	4.44±0.02 a	4.77±0.02 a	4.81±0.02 a	4.94±0.09 a	4.88±0.26 a
Fiber	13.62±0.68 a	11.23±0.09 b	8.93±0.20 c	8.71±0. 20 cd	8.71±0.03 d
NEF	35.14±0.94 c	37.08±0.57 b	37.91±0.50 ab	38.14±0.61 ab	38.85±0.32 a
Total energy(kJ g−1)	18.94±0.89 d	18.66±0.13 cd	19.17±0.19 bc	19.67±0.49 ab	19.26±0.22 a

Experimental procedure: Nile tilapia (*Oreochromis niloticus*) with an average initial body weight of (2.1g±0.2) was used in this experiment. The fish were obtained from Pusat Pengembangan Akuakultur Jitva, Kedah, Malaysia and were conducted in the Fresh Water Hatchery, Faculty of Fisheries and Aqua-Industry,University Malaysia Terengganu, Terengganu, Malaysia.

The experimental fishes were adapted for two weeks in the big tank (1500 L /V) and fed a commercial food during this period. At the beginning of the experiment, a total number of 450 fingerlings of Nile tilapia apparently healthy and free from any external parasites were chosen. The fishes were weighed and then distributed randomly into five experimental groups with three replicates for each group, 30 fishes for each tank. The fishes were fed at 5% of their body weight per day, and feed divided into two equal feedings (fed at 08.00 and 17.00 h). Fishes were weighed once every 2 weeks. The duration of the trial diets was 12 weeks.

Biological evaluation in fish: The data from the trial diets calculated the following growth related parameters according to Jauncey and Ross[15].
Average Weight Gain (AWG) = Average final weight (g) – Average initial weight (g)
Percent Weight gain = (W2 - W1 / W1) □□100

Where, W1 is the Average initial fish weight and W2 is the Average final fish weight.
Specific Growth Rate (SGR %/day) = 100 [Ln Wt1 – Ln Wt 0 / T]

Where: - Ln: normal log Wt 0: initial weight (g).Wt 1: final weight (g) T: time of days.
Feed Conversion Ratio (FCR) = Total feed consumption/ weight gain
Percent survival (%) = Final fish number / initial fish number

Statistical analysis: For evaluation of the results of the current study were used one-way analysis of variance (ANOVA) of the trial diets and Duncan's multiple range tests.

Result and Discussion

During the feeding trial, the fish readily accepted the diets and no disease symptoms during the trial period, and also the survival rate of each dietarygroupwas100%. The growth responses under different treatments are given in table 3. The initial body weights of the various dietary groups were similar, but the performances significantly different ($p < 0.05$) in terms of specific growth rate (SGR), and food conversion ratio (FCR). The best SGR was obtained of fishes fed with feed E (1.44±0.04), but no significant difference compared with control, while fishes fed with feed B exhibited the lowest SGR value (1.34±0.05).Weight gain increased with an increase of dietary maltose levels from 20 % to 25 %, and thereafter decreased significantly ($p < 0.05$). However at 20 % to 25 %, maltose levels the weight gain of fish increased linearly with an increase of maltose level. Feed conversion ratio (FCR) in fish fed on 35% maltose (1.01) were significantly better than the FCR of fishes fed 20 , 25 and 30% maltose (1.16 to 1.26) and FCR of fish fed 20% maltose (1.26) was significantly lower compared to all groups, but not significantly different to fish fed 35% and control (1.07).

Discussion: Dietary carbohydrate utilization by fishes is varied and appears to be related to the complexity of carbohydrate[2]. In addition, the utilization of the dietary disaccharide by fish higher than monosaccharide[11] and maltose shows better utilization among the three disaccharide followed by sucrose, and lactose[10]. In this study, there latively higher growth of Niletilapia fed with 35% maltose in the diet containing is similar to report on juvenile tilapia, *O.niloticusXO.aureus*[10]. The increase in the growth of fish with increasing dietary carbohydrate was described by Bergot[16]and Anderson *et al,*[17].It agrees with studies result so fIghwela,*etal*[18]when the mean condition coefficient (K) for the *Oreochromisniloticus* which fed on maltose is above average condition, making good use of its source and good health condition through the experiment.

Table-3
Effect of the experimental diets on Growth performance of Nile tilapia(*Oreochromis niloticus*)

	Maltose				
Items	**Feed A (0.0 %)**	**Feed B (20 %)**	**Feed C (25 %)**	**Feed D (30 %)**	**Feed E (35 %)**
Initial weight(g)	1.19±0.40	1.14 ±0.38	1.30±0.43	1.32±0.44	1.36±0.45
Final weight(g)	25.79±0.33	22.08±0.45	24.25±1.33	24.09±0.86	27.40±0.40
Weight gain(g)	24.20±0.23 ^{ab}	20.55±0.41 ^{c}	21.84±0.64^{bc}	22.34±0.84^{bc}	25.59±0.42^{a}
SGR*	1.41±0.05ab	1.34±0.05c	1.33±0.03bc	1.38±0.04bc	1.44±0.04a
FCR**	1.07±0.01 ^{bc}	1.26±0.03 ^{a}	1.16±0.06 ^{ab}	1.16±0.04 ^{ab}	1.01±0.02 ^{c}
Survival rate (%)	100	100	100	100	100

* SGR (Specific growth rate). ** FCR (Feed conversion ratio).

The specific growth rates (SGR) in the present study are agreement with Arockiaraj *et al*[19] when fed Striped Murrel (*Channastriatus)* Fingerlings with seven different levels of carbohydrate. Furthermore, Nile tilapia fingerlings have a habit of to be fatter indicating that they may be able to better utilize carbohydrate for growth. The better maltose level utilization by tilapia fingerlings may be related to its natural diets. The Nile tilapia is omnivores in nature[20, 15]and it mainly feeds on a diet containing some carbohydrate throughout the fingerling stages, mainly on zooplankton.

The food conversion ratios (FCR) in the present study are agreement with Sado and Bicudo[21]when fed Juvenile Nile Tilapia, *Oreochromis niloticus* with dietary Mannan oligosaccharides. Furthermore, the variance between the 20% FCR and 35% FCR was significant over the total time interval. This could be caused by the high amount of fibre in the 20% treatment diet. This variance also might be due to the tilapia in the 20% refused to consume the higher amount of cellulose. Due to the lack of a method for collecting uneaten food, the latter explanation cannot be confirmed or ruled out.

Conclusion

The most interesting conclusions resulting from the present study may be summarized as follows: Nile tilapia was able utilize up to 35% maltose in diet, and this result will have great benefits to the aquaculture industry as it will reduce their operational costs.

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